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OPTIMIZATION OF GRINDING PARAMETERS IN AUSTENITIC STAINLESS STEEL AISI 317L USING TAGUCHI METHOD

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ABSTRACT

Grinding is a process for final completion of components to ensuring smooth surfaces and high tolerances. When comparing with other operations, grinding is, the costlier process that is used under optical conditions. AISI 317L material was surface finished under various input parameters. Since it is more hardness and non- magnetic material. The main objective of the work is to study the grinding behavior and obtaining the optimal operating process parameters. It consists of several parameters such as chemical composition of work piece, depth of cut, wheel speed, feed rate, grain size, etc. The main objective of grinding process is to minimize the surface roughness value, which is to be identified in this paper.

KEYWORDS: AISI 317L, Chemical Composition & Grain Size

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Original Article

INTRODUCTION

Grinding is an important process for final completion of components ensuring smooth surfaces and high tolerances. As compared with other operations, grinding is the costlier operation that is used under optical conditions. Amandeep sigh padda et al (2015), the major significant factor in surface grinding is a wheel speed followed by grain size and finally depth of cut. Dasthagiri et al(2015), Optimization studies on surface grinding process parameters using RSM method. He observed that there is not much error between the experimental values and predicted values and the error is obtained above 4 to 8 %. Jejurkar et al (2016), told about influencing parameter of material removal rate is the speed. The optimum parameters of surface grinding overcome a problem of poor chip breaking and machining distortion. Manwatkar et al (2016), mentioned if the coolant flow rate is not sufficient at higher grinding wheel speed, then wear of abrasive grains (glazing) occurs and it decreases grinding rate. Ozel et al investigated hard machining of AISI H13 steel to find the effect of cutting parameters on surface roughness and found that the parameters are significant. Okada et al. Reported the tool the performance of tools (CBN and carbide coated PVD) in milling hardened steel. Gaurav Bartarya and S.K. Choudhury have discussed the special circumstances of hard cutting. The investigations focused on the effect of different cutting parameters, tool geometry, tool wear, surface integrity, a formation of the white layer, cutting forces and temperatures, numerical analysis of chip removal process, etc. Even so, there is a large demand to recognize the optimal and well -controlled circumstances for hard machining of different materials.

The main objective of the work is to understand the grinding behavior and obtaining the optimal operating process parameters. It consists of several parameters such as chemical composition of workpiece, depth of cut, wheel speed, feed rate, grain size etc. The main objective of grinding process is to minimize the surface

roughness value.

EXPERIMENTAL SETUP AND WORKING

The experiments were carried out in Atari horizontal hydraulic spindle surface grinding machine. The dimension of stainless steel AISI 317L plate with the dimensions of 35 mm x 25mm x 20mm was used as the work material. Spindle speed -2800 rpm, Table size of the surface grinding machine - 450 x 150mm, Speed of the grinding wheel -3200 rpm, Size of the grinding wheel is made up of SiC of dimension- 150 mm diameter, 13 mm thickness and 31.75 mm bore.

Figure 1: Grinding of Specimen

Figure 1. shows the processing of the specimen. Since the material is non -magnetic, a vice is prepared to fix the material in the magnetic bead. After fixing the vice the specimen is made to fix in the vice. The grinding wheel is fixed and tightens to avoid unbalancing of the wheel during the grinding process. Wheel dressing is done to provide the sharp edges of the wheel.

Figure 2: Grinding Wheel CG120

Figure 3: Grinding Wheel CG60

After, the initial set up the specimen is processed for the different orthogonal experiments. The grinding wheel CG120 is changed during the next half of the experiment. Work piece material used for the study was AISI 317L and its mechanical properties.

Table 1: Mechanical Properties of AISI 317L

Properties	Values
Tensile strength	590 Mpa
Modulus of elasticity	200 Gpa
Yield strength	260 Mpa
Hardness	90 (Rockwell B scale)
Poisson's ratio	0.3

METHODOLOGY USED: TAGUCHI METHOD

Design of Experiment

In this paper, we chose Smaller the better for getting better surface roughness the calculation purposes.

Table 2: Grinding Parameters and Their Levels

Parameters	Level 1	Level 2	Level 3
Grain Size(Mesh)	60	120	-
Depth Of Cut(Microns)	20	30	40
Feed(mm)	0.2	0.5	0.8

The qualities over which these procedure parameters differ are known as levels. Coarseness size is a two -level variable. Alternate elements specifically sustain and profundity of cut is three level variables. Orthogonal array (L_{18} (2^1*3^2)

Table 3: L_{18} (2^1*3^2) Orthogonal Array with Surface Roughness Value

Exp no	Grain size(mesh)	Depth of cut(microns)	Feed(mm)	Ra(micron)
1	60	20	0.2	0.236
2	60	20	0.5	0.290
3	60	20	0.8	0.531
4	60	30	0.2	0.288
5	60	30	0.5	0.270
6	60	30	0.8	0.398
7	60	40	0.2	0.323
8	60	40	0.5	0.351
9	60	40	0.8	0.357
10	120	20	0.2	0.163
11	120	20	0.5	0.259
12	120	20	0.8	0.302
13	120	30	0.2	0.192
14	120	30	0.5	0.261
15	120	30	0.8	0.302
16	120	40	0.2	0.226
17	120	40	0.5	0.301
18	120	40	0.8	0.718

RESULTS AND DISCUSSIONS

Taguchi Analysis: Ra versus Grain Size, Depth, Feed

Smaller is better as quality characteristics for surface roughness.

Table 4: Response Table for Signal to Noise Ratios

Level	Grain Size	Depth	Feed
1	9.648	11.114	12.696
2	11.168	11.098	10.841
3		9.013	7.687
Delta	1.520	2.100	5.009
Rank	3	2	1

Table 5: Regression Analysis: Ra versus Grain size, Depth, Feed

Exp no	Grain Size(Mesh)	Depth of Cut(Microns)	Feed(mm)	Ra(Micron)	S/N RATIO
1	60	20	0.2	0.236	12.54175994
2	60	20	0.5	0.290	10.75204004
3	60	20	0.8	0.531	5.498109578
4	60	30	0.2	0.288	10.81215024
5	60	30	0.5	0.270	11.37272472
6	60	30	0.8	0.398	8.002338559
7	60	40	0.2	0.323	9.815949553
8	60	40	0.5	0.351	9.093857671
9	60	40	0.8	0.357	8.946635678

Table 5: Contd.,					
10	120	20	0.2	0.163	15.75624791
11	120	20	0.5	0.259	11.73400472
12	120	20	0.8	0.302	10.39986114
13	120	30	0.2	0.192	14.33397543
14	120	30	0.5	0.261	11.66718985
15	120	30	0.8	0.302	10.39986114
16	120	40	0.2	0.226	12.91783122
17	120	40	0.5	0.301	10.42867009
18	120	40	0.8	0.718	2.877511115

Table 6: Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	4	0.272106	0.068027	100.52	0.000
Grain size	1	0.006265	0.006265	9.26	0.009
Depth	1	0.001280	0.001280	1.89	0.192
Feed	1	0.003726	0.003726	5.51	0.035
SNRA1	1	0.129965	0.129965	192.04	0.000
Error	13	0.008798	0.000677		
Total	**17**	**0.280904**			

The results obtained from the experiments are compared with the predicted value calculated from the model It can be seen that the regression model is reasonably well fitted with the observed values.

The residues, which are, calculated as the difference between the predicted and observed value lies in the range of -0.05 to 0.05. An experiment was carried out at the optimal parametric settings for surface roughness so that the targeted value of response parameter can be obtained.

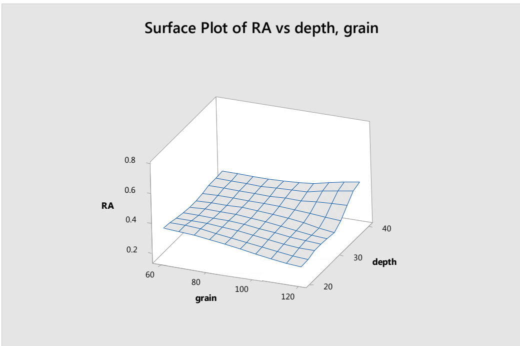

Figure 5: Surface Plot of RA vs Depth, Grain

Figure 5 depicts the effect of depth and grain size on surface roughness. According to this figure, the value of surface roughness increases with increase in grain size and decrease with depth.

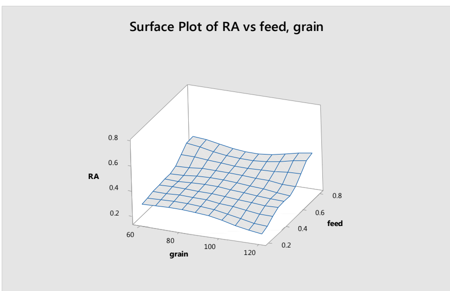

Figure 6: Surface plot of RA vs Feed, Grain

Figure 6 depicts the effect of feed and grain size on surface roughness. According to this figure, the value of surface roughness increases with grain size and decrease with feed

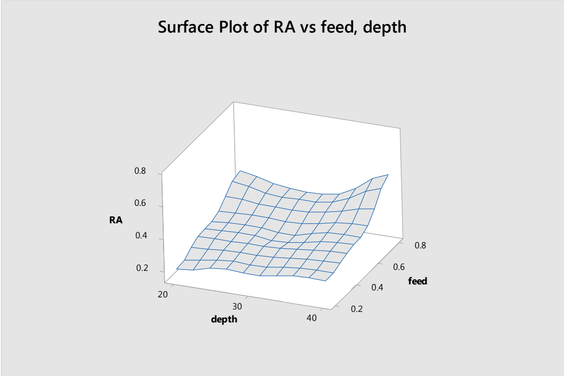

Figure 7: Surface plot of Ra vs. Feed, Depth

Figure 7. Depicts the effect of feed and depth on surface roughness. According to this figure, the value of surface roughness increases with a decrease in depth and feed.

The confirmation experiment for the better optimal parameter was set to its selected levels was conducted for quality characteristics evaluation of grinding of stainless steel AISI 317L grade. Table 7. Shows the experimental results obtained using the initial grinding parameters on stainless steel AISI 317L. Thus the response values obtained from the confirmation experiment are Ra = 0.1650 µm

Table 7: The Best Working Conditions for Response

Response	Grain size	Depth(microns)	Feed(mm)
Ra(microns)	120	20	0.2

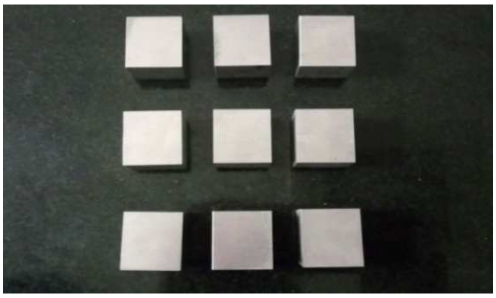

Figure 8: AISI 317L after Grinding

CONCLUSIONS

This paper is an application of Taguchi method to improve the Surface roughness in the grinding of stainless steel AISI 317L and it was reported. Finally optimization of complicated performance characteristics and it does not involve tedious mathematical calculations. This can be useful for industry peoples in the manufacturing world. This study develops surface roughness models for three different parameters, namely grain size, depth of cut and feed for grinding process of stainless steel AISI 317L using Taguchi method. Analysis of variance was found to find the significant parameters to get better Ra. Optimum machining parameter combinations for different roughness parameters are also tested through confirmation experiments that show reasonably good concurrence with a prediction of the response surface method.

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